1746

INCINERATION INFORMATION PACKAGE

Regulation proposal:	Amendment of Regulation 347 to Remove the Ban on New Municipal Waste Incinerators
Regulation proposal:	Exemption Order for Waste Management Planning by Municipalities
Policy proposal:	Establishing Guideline A-7 - Combustion and Air Pollution Control Requirements for New Municipal Waste Incinerators
	Rational for the Development of Guideline A-7

Ontario

Ministry of Environment and Energy

Ontario

Ministry of Environment and Energy

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An Invitation to Comment

This package contains material related to new municipal waste incinerators including:

- An amendment to Regulation 347 which removes the ban on new incinerators
- An exemption order for municipalities currently undertaking environmental assessments for waste management planning
- Guideline A-7 which contains proposed emission limits for new incinerators
- A rationale for the development of Guideline A-7

Interested individuals are invited to comment by making written submissions by mail or fax to:

EBR Incineration Comments
Science and Technology Branch
Ministry of the Environment and Energy
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Fax: (416) 323-5031

Additional copies of this package can be ordered from the ministry's Public Information Centre toll free at 1-800-565-4923 or in Toronto at 323-4321.

Pour tout renseignement en français sur les directives en matière d'incinération, veuillez composer le 416-323-5200.

Pibs # 1746e

DRAFT REGULATION AMENDMENT

REGULATION TO AMEND
REGULATION 347 OF THE REVISED REGULATIONS OF ONTARIO, 1990
MADE UNDER THE
ENVIRONMENTAL PROTECTION ACT

1. The definition of "municipal waste incinerator site" in section 1 of Regulation 347 of the Revised Regulations of Ontario, 1990 is revoked.

2. Section 12.1 of the Regulation is revoked.

EXEMPTION

Waste Management Planning by Municipalities

A number of municipalities in the Province of Ontario, including groups of municipalities who have together sponsored waste management studies, have recently gone through or are going through planning processes respecting waste management and have identified or are about to identify undertakings for the disposal of municipal waste as a result of such planning processes.

These planning processes were carried on entirely or substantially during a period of time when it was illegal to establish a new municipal waste incinerator site in Ontario. These were made illegal by Ontario Regulation 555/92, which added section 12.1 to Regulation 347 (Waste Management). They remain illegal until the said s. 12.1 is revoked.

Accordingly, these planning processes did not seriously address the alternative of incineration of municipal waste. Environmental assessments resulting from these planning processes will not address incineration and may fail to comply with s. 5 of the *Environmental Assessment Act* for that reason. It appears desirable that these undertakings be exempted pursuant to section 29 of the Act from the provisions of subsection 5(3) of the Act, to the extent that these provisions may require the incineration of municipal waste to be addressed as an alternative to an undertaking or an alternative method of carrying out an undertaking.

I am advised that if these undertakings are subject to all of the requirements of s. 5 of the Act, the following injury, damage or interference with the persons or property indicated will occur:

A. municipalities, including municipal sponsors of waste management studies, will be delayed and put to considerable expense if they must repeat or amend their planning processes so as to address incineration;

B. persons resident in such municipalities may be inconvenienced by the lack of disposal capacity available to the municipalities as a result of the delays mentioned.

Having weighed such injury, damage or interference against the betterment of the people of the whole or any part of Ontario by the protection, conservation and wise management in Ontario of the environment which would result from the undertaking being subject to the application of the act;

The undersigned is of the opinion that it is in the public interest to order and orders that any waste disposal undertaking by any municipality, including a group of municipalities who have together sponsored a waste management study, is exempt from the provisions of subsection 5(3) of the Act, to the extent that such provisions may require the incineration of municipal waste to be addressed as an alternative to an undertaking or an alternative method of carrying out an undertaking, for the following reason:

A. to avoid the above-noted injury, damage or interference.

This exemption is subject to the following terms and conditions:

1. This exemption applies only to municipalities, including groups of municipalities who have together sponsored waste management studies, which have substantially completed their analysis of "alternatives to" (as defined in subsection 5(3) of the Act) and have provided notice in writing of substantial completion of the analysis to the Director of the Environmental Assessment Branch, within one year of the date of approval of this exemption.

Draft for EBR information package

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Minister of Environment and Energy

DRAFT

GUIDELINE A-7

COMBUSTION AND AIR POLLUTION CONTROL REQUIREMENTS FOR NEW MUNICIPAL WASTE INCINERATORS

Legislative Authority:

Environmental Protection Act, Part V, Section 27, and Part II, Section 9
Ontario Regulation 347, General -- Waste Management Regulation
Ontario Regulation 346, General -- Air Pollution

Responsible Director:

Director, Science and Technology Branch

Last Revision Date:

July, 1995

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SYNOPSIS

This guideline applies to new municipal waste incinerators. The Ministry will enforce the guideline by imposing conditions on Certificates of Approval in accordance with the requirements of the *Environmental Protection Act*, Part V, Section 27, and Part II, Section 9. The requirements of this guideline supercede those of Guideline A-1 for municipal waste incinerators; however, it should be noted that this guideline does not apply to biomedical waste incinerators.

The guideline seeks to minimize contaminant air emissions from new incineration systems by requiring proper control of the combustion process and establishing minimum design and operating parameters for the evaluation of combustion. The Ministry will also consider these parameters when evaluating existing incinerators and assessing proposals for their upgrading.

The guideline also requires the installation of air pollution control systems, sets air emission limits for particulate, acidic gases, metals and dioxins/furans and establishes requirements for the control, monitoring and performance testing of incineration systems. Emission limits specified in this guideline will be reviewed and updated from time to time by the Ministry to reflect technology improvements and new health and environmental information.

1.0 INTRODUCTION

This guideline establishes minimum design and operating parameters, emission control systems and emission limits which will ensure control of emissions to the atmosphere from municipal waste incinerators. It also provides criteria which the Ministry will consider for evaluating existing incinerators and assessing proposals for their upgrading.

The requirements specified in this guideline are in addition to those in Regulation 346 (RRO 1990), General -- Air Pollution, including compliance with the point of impingement standards prescribed in Schedule 1 to that regulation.

2.0 DEFINITIONS

Burner Flame Front:

The visible luminous front zone of the flame, formed by the burner, in which intense localized gas phase combustion occurs.

Combustion Air:

The air supplied to the incinerator for the burning of the waste and/or the fuel.

Combustion Gas Residence Time:

The mean period of time, after most of the mixing and combustion has been completed and the temperature fully developed, during which the combustion gases are maintained at the specified minimum temperature and oxygen content.

Feed Rate:

The weight of waste introduced or fed into the incinerator per unit time.

Gas-Phase Turbulence:

Turbulence in the combustion gases, denoting an irregular fluctuation (i.e. mixing and eddying) superimposed on the main stream. Good mixing of the products of incomplete combustion (primarily carbon monoxide and hydrocarbons) and of the combustion air is promoted by a highly turbulent flow of the gases.

Negative Pressure:

A pressure that is less than ambient pressure.

Operating Parameters:

The variables of the incinerator process and waste stream used to control the operation of the incinerator. These include: the waste feed rate, composition, and heating value; combustion air feed rate(s); and heat losses and production.

Primary and Secondary Chambers:

The primary combustion chamber, also called the lower or combustion chamber, is where the waste is introduced, progressively dried, volatilized (gasified), ignited and combusted. Combustion is maintained by supplying the chamber with combustion air and heat from the primary chamber burner when necessary.

The gases flow from the primary combustion chamber to the secondary combustion chamber, also called the afterburner, where additional combustion air is mixed with the combustible gases to ensure their complete combustion.

Reference flue gas conditions:

Reference flue gas conditions are defined as follows:

• Temperature	25°C
• Pressure	101.3 kPa
• Oxygen content	11%
• Water content	nil (dry conditions)

Residual Oxygen:

The amount of oxygen (usually expressed in percent on a dry basis) in the combustion gases exiting the secondary combustion chamber or the location where the one-second residence time ends.

Single Chamber Mass Burning Incinerator:

A single chamber incinerator with a waterwall or refractory-lined construction, a grate onto which the waste is fed, and provisions for the supply of combustion air both beneath (underfire air) and above (overfire air) the grate. The waste is usually introduced into the incinerator with little or no pre-processing.

Spreader Stoker Incinerator:

A single chamber incinerator in which waste is blown with air into the incinerator furnace through a pneumatic charging system. Waste is burned in suspension and on a travelling

grate. The incinerator includes provisions for the supply of combustion air both beneath (underfire air) and above (overfire air) the grate.

3.0 ABBREVIATIONS

HCl	hydrogen chloride or hydrochloric acid
kg/h	kilograms per hour
kPa	kilopascals
mg/Rm^3	milligrams per reference cubic metre
ng/Rm^3	nanograms per reference cubic metre
O_2	oxygen
ppmv	parts per million by volume
R	reference conditions
$\mu g/Rm^3$	micrograms per reference cubic metre

4.0 GUIDELINE REQUIREMENTS

4.1 Combustion in Incinerators

4.1.1 Incineration Temperature

Incinerators shall be capable of maintaining, on a continuous basis, an incineration temperature of at least 1100°C, and shall operate at a temperature of not less than 1000°C. They shall incorporate an auxiliary burner to provide this minimum operating temperature:

- at start-up before the commencement of the incineration cycle;
- during shutdown until all combustion of waste has ceased; and
- when necessary during other phases of operation.

4.1.2 Combustion Air Distribution

Primary and secondary combustion air systems for incinerators shall be designed to control air distribution. Control systems shall provide the capability to adjust the distribution of combustion air and to automatically adjust the quantity of combustion air to respond to the range of waste properties, incinerator feed rates, and irregularities in loading and/or burning patterns in the incinerator.

4.1.3 Residence Time

Incinerators shall be designed for a combustion gas residence time of not less than one second at 1000°C. This residence time shall be calculated from the point where most of the combustion has been completed and the incineration temperature has fully developed.

(a) Multi-chamber Incinerators

In multi-chamber incinerators, the residence time shall be calculated from the secondary burner(s) flame front. If air is introduced downstream of the burner flame front, residence time shall be calculated from the final air injection point.

(b) Single-chamber Incinerators

Where the furnace is one continuous space, such as in "spreader stoker" and "single chamber mass burning" designs, the location of the complete combustion/fully developed temperature point shall be determined by an overall design review, and may be significantly downstream of the final air injection point.

4.1.4 Oxygen Availability

Incinerators shall be designed to provide and shall operate at not less than 6% residual oxygen in the flue gas exhaust during the incineration cycle.

4.1.5 Turbulence and Mixing

Incinerators shall be designed to provide and maintain a high degree of gas phase turbulence and mixing in the secondary combustion zone. Provisions shall include any combination of: appropriately located/directed air jets, changes of flue gas flow direction, baffling, and constriction of cross-sectional flue gas flow area.

4.1.6 Range of Operation

Incinerators shall be designed to achieve the temperature, residence time, oxygen availability and turbulence requirements of this guideline over the entire expected range of values of the incinerator operating parameters, including:

- feed rate (including minimum and maximum rates);
- ultimate analysis, heating value, ash and moisture content of the waste;
- combustion air; and
- heat losses.

4.1.7 Pressure Control and Emergency Exhaust

Incinerators shall be designed to operate under negative pressure during all phases of operation. Emergency exhausts shall not be located prior to the point at which the one-second residence time at 1000°C has been achieved.

4.1.8 Control and Monitoring Systems

Incinerators shall incorporate control and monitoring systems to ensure, readily indicate and confirm that the requirements of this guideline, as well as other Ministry standards, regulations and guidelines, are consistently met. Control and monitoring systems shall be capable of readily signifying and correcting any aspect of a substandard operation.

4.1.9 Continuous Monitoring Parameters

Continuously monitored parameters shall include temperature(s), total hydrocarbons (or carbon monoxide), and opacity. Monitoring may also be required for residual oxygen, carbon dioxide, incinerator exhaust flue gas volume, hydrogen chloride, sulphur oxides, nitrogen oxides and other parameters. Continuous monitors shall be equipped with recording devices for subsequent reference and analysis.

4.2 Air Pollution Controls For Incinerators

The emission limits listed in 4.2.1 through 4.2.6 will be reviewed and updated from time to time.

4.2.1 Particulate Outlet Concentration

Air pollution control systems for incinerators shall achieve a maximum outlet particulate loading of not greater than 11 mg/Rm^3.

4.2.2 Heavy Metal Concentrations

Air pollution control systems for incinerators shall achieve a maximum outlet concentration for heavy metals as follows:

for cadmium -- 7 μg/Rm^3
for lead -- 76 μg/Rm^3
for mercury -- 56 μg/Rm^3

4.2.3 Dioxin/Furan Concentration

Air pollution control systems for incinerators shall achieve a maximum outlet concentration of dioxins and furans, expressed as 2,3,7,8-TCDD toxicity equivalents according to the international toxicity equivalent factor method adopted by Canada in 1990, of 0.14 ng I-TEQ/Rm^3.

4.2.4 Hydrochloric Acid (HCl) and Sulphur Dioxide (SO_2) Concentration and Removal

Air pollution control systems for incinerators shall achieve either an HCl removal efficiency of not less than 95%, or a maximum guaranteed HCl outlet concentration of 18 ppmv (at

11% O_2 dry) based on the average of three 1-hour tests. This is equivalent to 27 mg/Rm^3 HCl.
Air pollution control systems for incinerators shall also achieve a maximum SO_2 outlet concentration of 21 ppmv (at 11% O_2 dry) based on the geometric average of 24 hours of data from a continuous emission monitoring system. This is equivalent to 56 mg/Rm^3 SO_2.

4.2.5 Nitrogen Oxides (NO_x) Emission Concentration

See attached annex

4.2.6 Continuous Operation

Air pollution control systems for incinerators shall be designed to operate on a continuous basis, as much as possible, whenever there is waste burning in the incinerator. The design of the system shall incorporate consideration of:

- the conditions which could lead to an unscheduled shutdown of the air pollution control system;
- means of ameliorating such conditions; and
- air pollution control bypassing which cannot be avoided.

The incinerator system controls shall be designed to ensure the shutdown of the incinerator immediately upon an unscheduled shutdown of the air pollution control system in a manner that will minimize air emissions. The control system shall also be designed to record pertinent information for subsequent reporting to the local District Office of the Ministry, and for an assessment of the reasons for the shutdown and potential measures to prevent a recurrence.

4.2.7 Performance Tests

The Director of the Ministry's Approvals Branch will determine the frequency of performance tests.

The removal efficiency and/or outlet loadings as described above in sections 4.2.1 and 4.2.4 shall be demonstrated by performance test programs approved by the Science and Technology Branch and, where applicable, by methods included in the Source Testing Code (Procedure A-1-1).

Performance tests shall be undertaken within six months of start-up and, thereafter, at a frequency of at least once a year or more often as determined by the Director. The performance test results shall be used to define the acceptable range of feed rates, operating procedures and range of readings for continuous monitoring devices. Any exceedance of the acceptable range for any monitor shall be reported to the local District Office of the Ministry.

ANNEX

The Ministry of Environment and Energy is following developments in nitrogen oxide (NO_x) control in the areas of technology, limits being set and environmental and health impacts. Both the USA's EPA proposed limit of 242 mg/Rm^3 and British Columbia's proposed limit of 350 mg/Rm^3 are being reviewed. The Ministry is concerned that there is no commercially available technology to consistently achieve the proposed emission limits.

The Ministry is inviting comments on an acceptable and achievable limit for NO_x stack emissions.

Rationale for the Development of Guideline A-7

Ministry of Environment and Energy

July 1995

Rationale for the Development of Guideline A-7

A. Introduction

The purpose of new Guideline A-7 is to provide rigorous emission limits for new municipal waste incinerators. The new emission limits are for particulate, hydrogen chloride and sulphur dioxide (acid gases) and lead, cadmium and mercury (heavy metals).

The existing requirements for new incinerators in Ontario were established in 1986 for the environmental hearing into the Peel Resource Recovery Inc. (PRRI) municipal waste incinerator in Brampton. These requirements were adopted as policy by the Ministry in 1986 and 1987 as Policy 01-01 for combustion control in incinerators and Policy 01-03 for air pollution control for incinerators. Both municipal waste incinerators and biomedical waste incinerators were covered by the guidelines. Some minor changes were made to the guidelines in 1989. The existing Ministry Guideline A-1 was produced in April, 1994 by combining the former Guidelines 01-01 and 01-03. No technical changes were made at that time.

The proposed revised guideline includes emission limits only for new municipal waste incinerators and has been designated as Guideline A-7. The new guideline is based on emission levels that are protective of the environment and human health and can be consistently attained by current, commercially available technology.

B. Review of Design Criteria

Section 4 of the present Guideline A-1 provides the requirements for municipal incinerators in Ontario. Sections 1, 2 and 3 deal with the introduction, definitions and abbreviations.

B.1 Good Combustion Practices

Section 4.1 of Guideline A-1 deals with technical criteria for combustion in incinerators including the following:

- incineration temperature
- combustion air distribution
- residence time
- oxygen availability
- turbulence and mixing
- range of operation
- pressure control and emergency exhaust
- control and monitoring systems and
- continuous monitoring parameters.

The Ministry considers that there is no need to change the combustion control guidelines.

The Ministry, therefore, focused on revising the emission limits in Guideline A-1. In setting the proposed emission limits, the Ministry considered:

- the risk to human health and the environment from incinerator air emissions,
- information available from incineration facilities in Ontario and other jurisdictions, and
- emission limits set or proposed in other jurisdictions.

B.2 Emission Data

Emission data were used for health risk evaluation and for evaluating the setting of emission limits.

The Ministry found that the available emission data that it deemed the most reliable and readily available were those for the PRRI incinerator in Brampton and the Greater Vancouver Regional District (GVRD) incinerator in Burnaby B.C. The air pollution control systems on these incinerators were considered the best available technology at the time they were established. In 1991, the GVRD upgraded the air pollution control system with the addition of carbon injection.

The PRRI data were available in stack testing reports carried out in compliance with the MOEE certificate of approval and in a report from the PRRI consultant.

The Burnaby data were available in a summary report entitled, "Burnaby Incinerator, Summary of Stack Monitoring Data" published in September 1992 by GVRD.

The Ministry also used data for the Hartford Connecticut refuse derived fuel incinerator.

B.3 Emission Limits in Other Jurisdictions

In setting emission limits, the Ministry considered emission limits set by the Canadian Council of Ministers of the Environment (CCME), British Columbia, the U.S. EPA (present limits) and the European Community. The proposed U.S. EPA emission limits were also considered.

Table 1 provides a summary of the emission limits from other jurisdictions. The proposed U.S. EPA limits are at least as rigorous and, in most cases, more rigorous than the limits from the other jurisdictions.

Table 1: Emission Limits in Other Jurisdictions

Contaminant	Guideline A-1 (present)	CCME	B.C. for Burnaby	U.S. EPA current >225 t/d	U.S. EPA proposed >225 t/d	Connecticut for Hartford	European Community
particulate (mg/Rm^3)	20	20	40	24	11	25	28
dioxins/furans (ng/Rm^3 I-TEQ or total)	NS	0.5 I-TEQ	0.5 I-TEQ	21 total	0.14 I-TEQ or 9 total	1.3 ng/Rm^3 I-TEQ	0.25 I-TEQ
HCl (mg/Rm^3)	50	75	55 average* (wet)	27 average*	27 average*	55 average*	31 7 day rolling avg.
SO_2 (mg/Rm^3)	NS	NS	200 24 hr. avg.	56 24 hr. avg.	56 24 hr. avg.	0.32 pounds per million BTUs	105 periodic testing
Nitrogen Oxides (mg/Rm^3 as NO_2)	NS	NS	350 24 hr. avg.	242 24 hr. avg. (mass burn only)	242 24 hr. avg. (mass burn only)	0.6 pounds per million BTUs	NS
Metals:							
Class I metals (Cd, Hg, Tl) ($\mu g/Rm^3$)	NS	NS	200	NS	NS	NS	142
cadmium (Cd) ($\mu g/Rm^3$)	NS	NS	in Class I	NS	7	NS	in Class I
mercury (Hg) ($\mu g/Rm^3$)	NS	NS	in Class I	NS	57	NS	in Class I
thallium (Tl)	NS	NS	in Class I	NS	NS	NS	in Class I
Class II metals (As, Co, Ni, Se,Te) ($\mu g/Rm^3$)	NS	NS	1000	NS	NS	NS	NA
Class III metals (Sb, Pb, Cr, Cu, Mn, V, Zn) ($\mu g/Rm^3$)	NS	NS	5000	NS	NS	NS	4629
lead (Pb) ($\mu g/Rm^3$)	NS	NS	in Class III	NS	71	NS	in Class III

* average of three 1-hour stack tests

I-TEQ = international toxicity equivalents, NS = no standard, NS = not available, t/d = tons per day
mg/Rm^3 = milligrams per reference cubic metre, ng/Rm^3 = nanograms per reference cubic metre,
$\mu g/Rm^3$ = micrograms per reference cubic metre
reference cubic metre = a cubic metre of flue gas at 25°C, 1 atmosphere pressure and 11% oxygen

Table 2 provides a comparison of the U.S. EPA limits and the average emissions from the PRRI, Burnaby and Hartford incinerators.

Table 2: Emission Data from Operating Incinerators

Contaminant	Proposed U.S. EPA Limits	PRRI	Hartford	Burnaby
particulate (mg/Rm^3)	11	3.3	14.2	9
dioxins/furans (ng/Rm^3 I-TEQ or total)	0.14 I-TEQ	0.29 I-TEQ	0.012 I-TEQ	<0.04 I-TEQ
cadmium ($\mu g/Rm^3$)	7	2.2	ND	2.3
lead ($\mu g/Rm^3$)	71	5	37	7
mercury ($\mu g/Rm^3$)	57	290	8.9	36
HCl (mg/Rm^3) average of three 1-hour stack tests	27	38	40	20 to 40
SO_2 (mg/Rm^3) 24 hour geometric average based on CEMS	56	7 to 117	187	30 to 200
NO_x (as NO_2) (mg/Rm^3) 24 hour arithmetic average based on CEMS	242	217 to 629	332	374

I-TEQ = international toxicity equivalents, NS = no standard, ND = not detected
mg/Rm^3 = milligrams per reference cubic metre, ng/Rm^3 = nanograms per reference cubic metre,
$\mu g/Rm^3$ = micrograms per reference cubic metre
reference cubic metre = a cubic metre of flue gas at 25°C, 1 atmosphere pressure and 11% oxygen
CEMS = continuous emission monitoring system

In the case of particulate, cadmium and lead, all three incinerators could meet the proposed U.S. EPA limits with the exception of particulate at Hartford. In the case of dioxins and

furans, Burnaby, with its carbon injection system met the limit as did Hartford but PRRI did not.

For mercury, no incinerator met the limit except Burnaby again because of the carbon injection system and Hartford because the waste is processed into a fuel prior to burning.

For the acid gases (HCl and SO_2), the incinerators met the limit at times; however, new facilities would be designed for a higher removal efficiency. For NO_x, no incinerator consistently met the proposed U.S. EPA limit.

B.4 Assessing the Risks from Incinerator Air Emissions

To evaluate the potential health impact of MSW incinerator emissions, either from existing facilities or from new facilities which operate under proposed U.S. EPA limits, the Ministry undertook screening level risk assessments on existing and proposed facilities. In the screening assessment, an adult human receptor was assumed to live in the zone near the incinerator where maximum ground level concentrations (GLC) occur on a long term basis (i.e., 70 years of continuous exposure). This Ministry's approaches to the assessment of health risks of incinerator emissions, definitions and terminology used are discussed in Appendix A.

Existing MSW Incinerators

The risk or potential for adverse effects was evaluated from the cumulative exposure ratio (ER) or integrated risk. For carcinogens, calculated lifetime risks of one-in-a-million (10^{-6}) are considered negligible. Some jurisdictions also consider one-in-100,000 (10^{-5}) to be negligible or non-significant. An ER of <u>less than</u> 1.0 would also indicate that no adverse effects are expected.

The aggregated lifetime risk of cancer due to inhalation of compounds with carcinogenic potential in emissions from existing MSW incinerators, PRRI and Hartford, was estimated as 1.3×10^{-6}.

This risk is considered to be "essentially negligible".

The cumulative ER for compounds with potential to be systemic toxicants in these MSW emissions was 0.16 or about 5 times <u>below</u> the "safe" exposure proposed for these compounds.

Risk assessment procedures for environmental receptors (plants, animals, fish, insects, etc.) and ecosystem effects are still being developed by scientists worldwide. Using the most applicable approaches, a preliminary screening of the impact of existing MSW incinerators emissions on soil quality and the terrestrial ecosystem has not revealed significant potential for damage to the ecosystem. Historically, damage to the terrestrial environment around

existing MSW incinerators in Ontario due to their emissions has not been found during soil sampling and other surveys.

Existing and Proposed Emission Limits

The results of the screening level risk assessment of proposed U.S. EPA limits are shown in Table A, Appendix A. For NO_x, the B.C. emission limit was used. Cadmium, which has carcinogenic potential was estimated to have a conservatively calculated lifetime risk from inhalation, soil exposure and produce consumption due to municipal waste incinerator emissions of 6×10^{-7}. This risk is considered to be "essentially negligible".

The other 6 compounds in these municipal waste incinerator emissions were estimated to have a cumulative ER of 0.004 or about 250 times below the "safe" exposure proposed for these compounds.

In summary, screening health assessments of emissions from existing and new municipal waste incinerators at Guideline A-7 limits indicate that these emissions have negligible direct impact on local air quality from a health perspective. Also, calculated exposures to soils and local produce subject to deposition from these emissions are not expected to result in adverse health effects in the local population.

C. Proposed Emission Limits

The Ministry is proposing to adopt the proposed U.S. EPA emission limits due to the fact that they achieve the Ministry objectives of:

- protecting human health and the environment,
- providing for a further reduction in emissions relative to the current MOEE emission limits, and
- being attainable using current, commercially available technology.

Furthermore, the U.S. EPA emission limits are considered rigorous and fully documented. A fuller description of the emission limits found in other jurisdictions is in Appendix B.

The only contaminant emission limit proposed by the U.S. EPA that the Ministry decided not to adopt at this time is the one for nitrogen oxides (NO_x). This limit only applies to mass burning incinerators. The Ministry is concerned that there is no commercially available technology that can consistently achieve the proposed U.S. EPA emission limits. Nevertheless, Guideline A-7 contains an Annex that invites comments on the acceptability and achievability of the U.S. EPA limit of 242 mg/Rm^3 and the B.C. limit of 350 mg/Rm^3 to limit NO_x emissions. The GVRD is testing a strategy for achieving a 350 mg/Rm^3 NO_x emission from the Burnaby incinerator, which is of a mass burn design. GVRD plans to implement the strategy by July 1996.

Because of the considerations noted above, it is proposed that Ontario adopt the proposed U.S. EPA emission limits for dioxins/furans, metals and acid gases for new municipal waste incinerators in Ontario. These are as follows:

- dioxins/furans - 0.14 nanograms per dry standard cubic metre of stack gases at reference conditions of 25°C and 1 atmosphere pressure measured as international toxicity equivalents;
- particulate - 11 micrograms per dry standard cubic metre of stack gases at reference conditions of 25°C and 1 atmosphere pressure;
- cadmium - 7 micrograms per dry standard cubic metre of stack gases at reference conditions of 25°C and 1 atmosphere pressure;
- lead - 71 micrograms per dry standard cubic metre of stack gases at reference conditions of 25°C and 1 atmosphere pressure;
- mercury - 57 micrograms per dry standard cubic metre of stack gases at reference conditions of 25°C and 1 atmosphere pressure;
- hydrochloric acid - 27 milligrams per dry standard cubic metre of stack gases at reference conditions of 25°C and 1 atmosphere pressure measured as the average of three 1- hour tests;
- sulphur dioxide - 56 milligrams per dry standard cubic metre of stack gases at reference conditions of 25°C and 1 atmosphere pressure measured as a 24 hour geometric average;
- nitrogen oxides - See Annex to proposed Guideline A-7.

References

Air Testing Services Inc, *Emission Testing Report, Peel Resource Recovery Inc. Energy from Waste Facility*, 1993.

A. John Chandler, *Operating Experiences with a Wet Spray Humidifier Dry Scrubber Fabric Filter at Peel Resource Recovery In., Brampton, Ontario*, in Proceedings of the AWMA Fabric Filtration Conference, 1994.

Greater Vancouver Regional District, *Burnaby Incinerator, Summary of Stack Monitoring Data*, September 1992.

Environment Canada, National Incinerator Testing and Evaluation Program (NITEP), *The Environmental Characterization of RDF Technology, Mid-Connecticut Facility, Hartford, Connecticut*, March 1991.

U.S. EPA, *Standards of Performance for New Stationary Sources: Municipal Waste Combustors*, in the U.S. Government Federal Register, Vol. 59, No. 181, September 20, 1994.

APPENDIX A

Assessing the Risks from Incinerator Air Emissions

In general, two approaches can be used in assessing the health risks from incinerator emissions:

(i) Site-Specific Risk Assessment (SSRA)

This approach provides a quantitative estimation of the risks specific to the type and construction of the incinerator being proposed and the site characteristics at which its planned location. Impacts on the ecological and human populations that are in the vicinity of the site are assessed. All pathways of exposure are evaluated, i.e., air inhaled, food, drinking water and soil ingested, and, dermally absorbed from soil and surface water. In addition, exposure from other sources such as consumer products are also considered. The assessment uses information and data that is specific to the situation and as such, strives to provide realistic estimates of the risk for the actual populations exposed near the proposed facility.

SSRAs have become an expected component of the Environmental Assessment submissions prepared by proponents in presenting a technical and social impact analysis of proposed facilities to the affected communities. The most recent SSRA for a municipal waste incinerator was completed in the late 1980s as part of the Environmental Assessment for the Peel Resource Recovery Inc. facility. The assessment indicated that no adverse effects or unacceptable risks from air emissions were expected from the operation of the facility. Current monitoring findings continue to support these conclusions.

(ii) Screening Level Risk Assessment (SLRA)

This approach is used to provide an upper estimate of the risk from incinerator emissions using very conservative assumptions. Since specific sites are not involved, more generic assumptions are made about the incinerator design, site characteristics and the populations exposed. SLRA are useful for assessing the impact of proposed emission limits or other changes to the municipal waste incineration process. SLRA can be used to rank the risks of individual chemicals in municipal waste incinerator emissions and set priorities for new emission standards.

Screening Level Health Assessments of Existing MSW Incinerators and the Proposed Guideline A-7 for Municipal Waste Incinerators

The intent of the SLRA is to provide an estimate of the potential for adverse health effects in human beings living near municipal waste incinerators for most of their lives using the most current information available. This estimate was derived as follows:

i) Emissions were Characterized

Existing Incinerators

In order to identify which compounds should appear on the screening list, recent stack monitoring data from the Peel Resource Recovery Inc. Incinerator and the Hartford Incinerator (a relatively new facility located in Connecticut, U.S.A.) were used to establish the chemicals and quantities emitted. These facilities were selected as representing intermediate and large sized facilities burning 400 tonne/day and 1500 tonne/day, respectively. Any compound which appeared on either monitoring list was considered for the initial stage of screening (in excess of 130 compounds were analyzed for).

This initial listing was reduced by removing compounds which were not detected at either facility. Since the compounds were not detected, there was no basis to assess any adverse health effects. Another 14 compounds were measured in incinerator emissions for which no reliable information on their toxicology was found.

Guideline A-7

A SLRA was undertaken to assess the implication of these new limits in a new hypothetical municipal incinerator and taking into account the most recent federal, Ontario and U.S. toxicological information available. It should be noted that if defensible health criteria were available that are more current than existing Ontario guidelines, then these values were used.

The new limits for Guideline A-7 were assumed to be emitted from a new facility similar in stack characteristics and operation to those at the Peel Resource Recovery Inc. facility.

ii) Exposures were Estimated

An important part of a SLRA is estimating human exposure. In the screening assessment, an adult human receptor was assumed to live in the zone near the incinerator where maximum ground level concentrations (GLC) occur on a long term basis (i.e., 70 years of continuous exposure). The GLC maxima were modelled using the Ministry CAP air dispersion models. The modelling was performed using the worst air meteorology data set for Ontario. Under these conditions, ground level concentrations are maximised.

Normally, a multi-media approach is used to estimate human exposure from all exposure pathways (i.e. through inhalation, ingestion of food, water and soil, and dermal exposure to soil). In this case, the contribution of the municipal waste incinerator emissions was limited to ground level air quality, soil quality (assuming that the incinerator emissions deposited on the soil for 70 years and were incorporated into the upper 5 cm) and consumption of backyard vegetables grown in this soil. The soil and produce exposure intakes were calculated using a California multi-media exposure model (CAPCOA 1993). Exposures to

tap water and the typical consumer food basket were not considered because local incinerator emissions are unlikely to enter tap water or supermarket produce.

Annual average GLC maxima were assumed to be inhaled on a lifetime basis. Intakes from contaminated soil or local produce exposures were estimated on the same basis for the metals and dioxins and furans. Only inhalation exposures were calculated for particulates and acid gases.

For the initial screening of the more than 130 chemicals found in existing MSW incinerator emissions, only the inhalation pathway was evaluated for chronic health impacts. Subsequently, the smaller list of chemicals found to account for 99% of the inhaled risk were further evaluated for intakes from contaminated soil or local produce exposures.

iii) Health Effects were Assessed

For the chemicals in existing MSW incinerator emissions (and Guideline A-7), potential adverse health effects were identified. Health effects may be systemic or carcinogenic. Systemic effects include: adverse effects on organs such as the kidney, lung; effects on biochemical functions, reproductive health and development, the immune system or the nervous system.

Systemic Acting Chemicals

In general, for systemic effects, dose-response information is utilized by regulatory agencies to develop acceptable exposure levels (eg. Acceptable Exposure Level (AEL); Acceptable Daily Intake (ADI); Tolerable Daily Intake (TDI) and Reference Concentrations (RfC) or Reference Doses (RfD)) below which adverse effects are not expected to occur. Protection factors, called safety or uncertainty factors, generally ranging from 10 to 1000, are applied to the no-effect-level or no-adverse-effect-level of the dose-response information to generate the AEL, ADI, TDI, RfC, or RfD. These criteria for systemic effects essentially represent an estimate of a daily exposure to the human population (including sensitive subgroups) that is likely to be without an appreciable risk of deleterious effects during a lifetime of continuous exposure. In some instances (for example, particulate emissions), health effects data were not available but regulatory guidelines were found and used in lieu of a RfD/RfC.

To determine the acceptability of systemic acting substances in emissions, the exposure ratio (ER) was calculated by dividing the calculated intake by acceptable exposure limits (RfC, TDI, RfD, etc.). An ER of 1 or less indicates a safe level of exposure; an ER of greater than 1 indicates that the receptor may be exposed to levels of the chemical which may cause adverse health effects.

Carcinogenic Chemicals

In quantitative risk assessment for cancer, carcinogenicity is often expressed in terms of a potency slope or cancer slope factor or unit risk. These are used for generating cancer risk estimates; in other words, for calculating the probability (risk) of cancer associated with a given exposure level. Since regulatory efforts are generally protective of public health, including sensitive members of the population, the cancer slope factors are derived using very conservative assumptions. Carcinogenic effects were recorded as risk per unit exposure, since most carcinogens are considered to have non-threshold dose-response curves. The exceptions are dioxins and furans. This family of compounds was treated separately from the other carcinogens in that a risk factor is not involved and a tolerable daily intake (TDI) (similar to a RfD) is used.

The risk was calculated by multiplying calculated receptor intakes by the appropriate risk per intake (unit risk) factor. Calculated lifetime risks of one-in-a-million (10^{-6}) to one-in-100,000 (10^{-5}) are considered negligible.

Database Used for Identifying Health Effects

In order to choose the information for health effects, literature was searched in the following order:

1. Ontario Ministry of Environment and Energy

   RfD/RfC and carcinogenic risk estimates. These documents have been released to the public domain and have received external review.

2. Health Canada/Environment Canada

   Tolerable Daily Intakes (TDI) or risk estimates developed under the Priority Substances Evaluation Program, *Canadian Environmental Protection Act* (CEPA). These documents have been released to the public domain and have received external review.

3. US Environmental Protection Agency - Integrated Risk Information System (IRIS)

   IRIS provides peer-reviewed and agency supported values for RfCs, RfDs and carcinogenic risk estimates.

4. Other EPA and State Criteria

   National Air Toxics Information Clearinghouse (US EPA)(NATICH), Health Effects Assessment Summary Tables (US EPA) (HEAST), California Air Pollution Control Officers Association (CAPCOA) - these data have undergone peer review. HEAST

and NATICH may contain guidelines for chemicals which have been withdrawn from IRIS.

Toxicological assessments developed in Ontario or Canada were given preference because they are believed to be the most relevant to the scenario that is being studied.

Table A: Risks of Guideline A-7 Emission Limits in a New Municipal Waste Incinerator

Parameter	stack gas ($\mu g/Rm^3$)	GLCmaxAA $\mu g/Rm^3$	Total Intake $\mu g/kg/d$	Criterion	Exposure Ratio	Risk	Endpoint	Reference
particulate emissions	11000	3.63E-03 (i.e. 3.63×10^{-3})	NC	50 $\mu g/m^3$	7.00E-05	*	systemic	HEAST, 1992
sulphur dioxide	56000	1.85E-02	NC	80 $\mu g/m^3$	2.30E-04	*	systemic	HEAST, 1992
hydrogen chloride	27000	8.91E-03	NC	7 $\mu g/m^3$	1.30E-03	*	systemic	IRIS, 1994
nitrogen oxides (as NO_2)	350000	1.16E-01	NC	100 $\mu g/m^3$	1.60E-03	*	systemic	HEAST, 1992
cadmium	7	2.31E-06	4.88E-06	0.0018 $\mu g/m^3$ 0.00548 $\mu g/kg/d$	*	2.67E-08	cancer	IRIS, 1994
lead	70	2.31E-05	4.73E-05	1.85 $\mu g/kg/d$	2.60E-05	*	systemic	MOEE, 1994
mercury	56	1.85E-05	4.85E-05	0.3 $\mu g/m^3$ 0.1 $\mu g/kg/d$	5.00E-04	*	systemic	MOEE, 1994
total dioxins (I-TEQ)	0.00014	1.19E-10	7.06E-11	10 pg/kg/d	7.00E-06	*	cancer	CEPA, 1991

Stack parameters based on Guideline A-7 limits in a new Peel-like municipal waste incinerator
Guideline emission limits assume correction for stack temperature to ground level (25°C)
GLCmax **annual average** values calculated using Guideline A-7 emissions from a Peel-like stack and **worst-case** Ontario meteorological data (Toronto Island).

GLCmaxAA = maximum Ground Level Concentration (Annual Average)
Risk = Risk for carcinogenic parameters
Exposure Ratio = Ratio of actual exposure/reference concentration. No systemic effects expected if ER ≤ 1
NC = not calculated (only inhalation criterion considered)

* cadmium is evaluated using a risk based criterion; the rest of the parameters are assessed using the exposure ratio criterion.

APPENDIX B

Emission Limits in Other Jurisdictions

Other jurisdictions have established emission limits for municipal waste incinerators and one, the U.S. EPA, proposed new emission limits for new facilities burning more than 225 tons per day in the September 20, 1994 Federal Register. British Columbia has a mass burning incineration facility with a lime- and carbon-injection air pollution control system in Burnaby which meets B.C. emission limits. Also, in 1988, the Canadian Council of Ministers of the Environment published minimum standards for Canada.

The principle emission limits provided are heavy metals (subdivided as Class I, Class II and Class III metals), dioxins and furans, and acid gases (hydrogen chloride and sulphur dioxide).

Ontario Regulation 346 (RRO 1990) specifies a regulatory limit for organic matter in combustion gases from a municipal waste incinerator of 100 parts per million expressed as equivalent methane.

All of the units in this Appendix are referenced to 25°C, 1 atmosphere pressure, 11% O_2 and dry conditions unless noted otherwise.

The following are the abbreviations used in this Appendix:

dscm	dry standard cubic metres (cubic metres of gas at 20°C, 1 atmosphere pressure, dry conditions)
HCl	hydrogen chloride or hydrochloric acid
I-TEQ	toxicity equivalents to 2,3,7,8-TCDD calculated using the international toxicity equivalent factor method
mg/Rm^3	milligrams per reference cubic metre
kg/h	kilograms per hour
kPa	kilopascals
ng/Rm^3	nanograms per reference cubic metre
O_2	oxygen
ppmv	parts per million by volume
R	reference conditions (25°C, 1 atmosphere pressure, 11% O_2 and dry conditions)
Rm^3	cubic metres at reference conditions
$\mu g/Rm^3$	micrograms per reference cubic metre

1.0 Heavy Metals Emission Limits for Other Jurisdictions and Technology Capability

1.1 Class I Metals (mercury, cadmium, thallium)

From data from tests carried out on the Burnaby, B.C. incinerator, emissions Class I metals consist of 99% mercury and 1% cadmium. No thallium was detected in the tests.

1.1.1 Canadian Emission Limits

British Columbia is the only Canadian jurisdiction that has an emission limit for Class I metals. The B.C. emission limit is 0.2 mg/Rm^3 or 200 $\mu g/Rm^3$.

The Canadian Council of Ministers of the Environment (CCME) in its 1988 guideline document did not set an emission limit for heavy metals since the particulate emission limit was to be a surrogate for heavy metals.

1.1.2 U.S. Emission Limits

At present, there is no U.S. EPA emission limit for mercury, cadmium or thallium; however, in the September 20, 1994 Federal Register, the U.S. EPA proposed an emission limit for mercury of either 57 $\mu g/Rm^3$ (0.080 mg/dscm[1] @ $7O_2$) or a mercury removal efficiency of 85% or greater for facilities burning more than 225 tons per day.

For cadmium, the U.S. EPA proposes an emission limit of 7 $\mu g/Rm^3$ (0.010 mg/dscm @ $7\%O_2$).

Thus, the U.S. EPA emission limit for Class I metals would be 63 $\mu g/Rm^3$.

There is no proposed or existing emission limit for thallium.

Compliance testing is to be performed by using EPA Reference Method 29.

1.1.3 European Emission Limits

The European Union emission limit for Class I metals (mercury + cadmium) is 142 $\mu g/Rm^3$. There is no emission limit for thallium.

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[1] milligrams per dry standard cubic metre. Standard conditions are 20°C and 1 atmosphere pressure.

1.2 Class II Metals (arsenic, cobalt, nickel, selenium, tellurium)

The only emission limit for Class II metals is a British Columbia emission limit of 1.0 mg/Rm^3 (1000 μg/Rm^3). The CCME controls these metals through its particulate emission limit. The U.S. EPA and the European Community do not have emission limits for these metals.

1.3 Class III Metals (antimony, lead, chromium, copper, manganese, vanadium, zinc)

The only metal of concern in the new U.S. EPA emission limits in this class is lead although B.C. and the European Community have emission limits for total metals in this class.

1.3.1 Canadian Emission Limits

British Columbia is the only Canadian jurisdiction that has an emission limit for Class III metals. The B.C. emission limit is 5.0 mg/Rm^3 or 5000 μg/Rm^3.

As noted above, CCME in its 1988 guideline document did not set an emission limit for heavy metals since the particulate emission limit was to be a surrogate for heavy metals.

1.3.2 U.S. Emission Limits

At present, there is no U.S. EPA emission limit for Class III metals; however, in the September 20, 1994 Federal Register, the U.S. EPA proposed an emission limit for lead of 71 μg/Rm^3 (0.10 mg/dscm @ 7%O_2) for facilities burning more than 225 tons per day. Compliance testing is to be performed by using EPA Reference Method 29.

1.3.3 European Emission Limits

The European Union emission limit for Class III metals is 4629 μg/Rm^3 (includes only lead, chromium, copper, and manganese).

1.4 Technology Capability

Tests on the PRRI, Burnaby and Hartford incinerators show that the following average emissions can be obtained for heavy metals:

For mercury:

- PRRI -- 290 μg/Rm^3
- Burnaby -- 36 μg/Rm^3
- Hartford -- 8.9 μg/Rm^3

For cadmium:

- PRRI -- 2.2 $\mu g/Rm^3$
- Burnaby -- 2.3 $\mu g/Rm^3$
- Hartford -- not detected

For lead:

- PRRI -- 9 $\mu g/Rm^3$
- Burnaby -- 7 $\mu g/Rm^3$
- Hartford -- 37 $\mu g/Rm^3$

Thus, all three incinerators can meet the proposed U.S. emission limit for cadmium and lead. Burnaby and Hartford meet the proposed standard for mercury, but PRRI does not.

2.0 Dioxin/Furan Emission Limits for Other Jurisdictions and Technology Capability

The emission limit for dioxins and furans is normally expressed as a weighted average of the 17 most toxic dioxins and furans based on the new International Method of weighting factors. The resulting number is the number of nanograms of 2,3,7,8-dibenzo-p-dioxin that would be equivalent to the toxicity of the dioxin/furan mixture (written as ng/Rm^3 I-TEQ).

2.1 Canadian Emission Limits

The Canadian emission limit for dioxin/furans is based on the CCME emission limit of 0.5 ng/Rm^3 I-TEQ at 11% O_2. The British Columbia emission limit is also 0.5 ng/Rm^3 I-TEQ. These are reported on a dry condition basis. Ontario does not presently have an emission limit for dioxins/furans.

2.2 U.S. Emission Limits

At present, the U.S. EPA requires incinerators to meet an emission limit of 21 ng/Rm^3 expressed as total dioxins and furans. The new proposed emission limit is 0.14 ng/Rm^3 I-TEQ at 11% O_2 on a dry basis (0.2 ng/dscm I-TEQ). Compliance testing is to be performed by using EPA Reference Method 23.

2.3 European Emission Limits

The European Community emission limit for dioxins and furans is 0.1 ng/Nm^3 (normal cubic metre at 0°C and 1 atmosphere) I-TEQ at 11% O_2 on a wet basis. The emission limit is based on the average of any three 6- to 16-hour runs. When this is calculated at dry reference conditions and 4-hour runs, the emission limit is approximately 0.25 ng/Rm^3 which is greater than the proposed U.S. EPA emission limit.

2.4 Technology Capability

Tests on the PRRI, Burnaby and Hartford incinerators show that the following average emissions can be obtained for dioxins/furans:

- PRRI -- 0.29 ng/Rm^3 I-TEQ
- Burnaby -- 0.04 ng/Rm^3 I-TEQ
- Hartford -- 0.012 ng/Rm^3 I-TEQ

Thus, the U.S. EPA emission limit can be met by an incinerator with carbon injection.

3.0 Acid Gas (Hydrochloric Acid and Sulphur Dioxide) Emission Limits for Other Jurisdictions and Technology Capability

Acid gas emissions of concern include hydrogen chloride (HCl) and sulphur dioxide (SO_2)

3.1 Canadian Emission Limits

The present Ontario emission limit for hydrochloric acid is 50 mg/Rm^3 or 90% removal efficiency, whichever gives the greater emission level. There is no existing emission limit for sulphur dioxide.

3.2 U.S. Emission Limits

The proposed U.S. EPA emission limit for hydrochloric acid is 27 mg/Rm^3 or 95% removal and for sulphur dioxide, 56 mg/Rm^3 or 80% removal. Compliance testing is to be performed by using EPA Reference Method 26. For hydrochloric acid, the average of three 1-hour tests would have to be less than the emission limit. For sulphur dioxide, the 24 hour geometric average from the continuous emission monitoring system (CEMS) would have to be less than the emission limit. It is important to include the averaging times in setting the emission limits.

3.3 European Emission Limits

The European Community emission limit for hydrochloric acid is 46 mg/Rm^3 and for sulphur dioxide, 275 mg/Rm^3.

3.4 Technology Capability

Tests on the PRRI, Burnaby and Hartford incinerators show that the following average emissions can be obtained for hydrochloric acid and sulphur dioxide:

- PRRI -- 38 mg/Rm^3 for HCl
- Burnaby -- 20 to 40 mg/Rm^3 for HCl and 100 to 200 mg/Rm^3 for SO_2
- Hartford -- 40 mg/Rm^3 for HCl

4.0 Particulate Emission Limits for Other Jurisdictions and Technology Capability

4.1 Canadian Emission Limits

The present Ontario emission limit for particulate is 20 mg/Rm^3.

4.2 U.S. Emission Limits

The proposed U.S. EPA emission limit for particulate is 11 mg/Rm^3 (15 mg/dscm @ 7%O_2). Compliance testing is to be performed by using EPA Reference Method 5.

4.3 European Emission Limits

The European Community emission limit for particulate is 28 mg/Rm^3.

4.4 Technology Capability

Tests on the PRRI, Burnaby and Hartford incinerators show that the following average emissions can be obtained for particulates:

- PRRI -- 3.3 mg/Rm^3
- Burnaby -- 9 mg/Rm^3
- Hartford -- 14.2 mg/Rm^3

Thus, both PRRI and Burnaby can meet the proposed limit; Hartford is slightly above the limit.